

connected to the ordinary channel drain electrode with a conductor.) The construction of the transistor provides the way for electrons to the drain through the thick channel while transistor is closed or is being switched off. The potential of the thick channel drain electrode has to be positive or zero or little negative relative to the potential of the drain electrode of ordinary channel. The high drain voltage extracts electrons from the thick channel which is disposed near the source. The potential of the thick channel source electrode has to be positive so that the thick channel is closed. (It is allowed that the potential of the thick channel source electrode might equal zero, if the threshold voltages equal approximately 0.2 volt).

(To achieve optimum characteristics three rather than two different levels of voltages should be applied to the transistor gates. One of the voltages to the gate is about zero relatively to the nearby source, with the transistor channel closed, while the voltage applied to the gate near the drain should be about 0.4 V with the channel slightly open and the gate emit(ing) very low hole current to the lightly doped area).

When changing polarity of the applied voltage (applied), the source and (the) drain change places, and (the voltages to the gates) the potentials of the thick channel electrodes should be changed accordingly so as the transistor is to remain closed. In this case the transistor can maintain voltages up to several kilovolt depending on parameters of the lightly doped area, in the first place from the thickness and number of donors between the gates as well as from an edge termination structure. To prevent an avalanche breakdown near the edge of the substrate, to decrease on-voltage, to increase speed of response and current density one might use a rib of rigidity of definite dimensions (fig. 11). The channels of the transistor have to dispose in the recess bottom. In this case the avalanche breakdown can occur on the gate boundary near the edge of the recess bottom or near the edge of the thick channel depending on the parameters.

Another voltage on the gates is about 0.8 V relatively of the (source) source and (the) drain which are nearby. It provides the opening of the channels and hole emission into the channels and the lightly doped area. The emission of holes to the lightly doped area is followed by electrons from the transistor source which makes the hole concentration and electron concentration practically the same in zero approximation and may reach the magnitude of  $10^{17} \div 10^{18} \text{ cm}^{-3}$ ; resistance of the transistor drops abruptly (sharply) due to conductivity modulation and the voltage between the drain and (the) source of the transistor as a rule does not exceed 0.5 V at current density  $\approx 1000 \text{ A cm}^{-2}$ . (The level of 0.4 V can be substituted by) There is a smoothly lowering voltage on the gate which is near the source of the transistor during the switching of the transistor from on-condition to off-condition, owing to extraction. To decrease the loss of switching off the voltage on the gate which is near the drain of the transistor should be decreased smoothly during the first part of time of switching off (approximately 1 us).

"paragraph 0011". To increase operating current of the (have completely controllable) transistor (without latch), the offered BSITs (offered) should have the channel with a low resistance. To this end, thickness of the channel should be small and the impurity concentration near the gate should be high enough so that the electronic current flowing near the gate could not cause a large voltage drop which, in turn, could lead to emission of holes. To meet these requirements, it is desirable to grow an epitaxial layer with donor impurity concentration being about  $10^{17} \text{ cm}^{-3}$  on the surface of the lightly doped substrate having the donor impurity concentration about  $10^{14} \text{ cm}^{-3}$ , and to have an equipment with higher resolution than is generally used for manufacturing other BSITs. The distance from the boundary of the epitaxial layer to the gate should be about 0.1  $\mu\text{m}$ . On the surface of a monocrystalline silicon a layer of a polysilicon may be disposed that would help to form the elements of the transistor -- the gate, the source, the channel and the electrodes. The other variant -- implantation of both donor and acceptor in the gate and double drive-in diffusion to provide thin layer donor

impurity near the gate.

"between paragraph 0011 and 0012". A solitary pulse current density (without switching off by the transistor) can be several times bigger, tending to 10000 a cm.sup.-2. Auger recombination restricts the carrier density. In this case the hole concentration is approximately the same in the whole lightly doped area. The influence of diffusion currents is negligible. The offered transistors, as the transistor [3], can control power greater than any other types of transistors all over the world.

"paragraph 0015". Apart from the main purpose of application, that is using the (transistor) device as a completely controllable power bidirectional key, (similar structure) the device can be used as transistor-thyristor (for other purposes); to achieve these purposes, both the control of emission and of extraction of holes into lightly doped area are used, as well as current feedback for the control of emission (for example, latch in the construction of high voltage breaker) (when manufacturing a switchboard). The current feedback provides the hole emission from the gate, which is near the drain of the device, if the resistance of the channel is high and the control circuit provides it (fig.13).

"between paragraph 0022 and 0023". Fig.11 represents the substrate structure with the ribs of rigidity.

Fig.12 represents the offered transistor with a part of the high voltage control circuit (one of several variants; for illustration only).

Fig.13 represents a part of the circuit of the high voltage breaker with offered transistor-thyristors (one of several variants; for illustration only).

"between paragraph 0025 and 0026". Fig.11 comprises the operation part of the substrate 131, ribs of rigidity 132, recess 133.

The ribs of rigidity increase a mechanical durability of the substrate and permit to decrease the thickness of the operation part and to improve the main performances of the transistor.

Fig.12 comprises the offered transistor 110, hole emission key 111, hole discharge (extraction) key 112, electron discharge key 113, amplifier with nonlinear feedback (polarity fixture) 114,115,113; diodes 116-120, hole emission key 121, hole discharge (extraction) key 122, electron discharge key 123, amplifier with nonlinear feedback (polarity fixture) 124,125,123; diodes 126-130; (transistors 111,112,113,121,122,123 -- low-voltage bipolar static induction transistors).

If the drain voltage exceeds a threshold voltage it extracts electrons from the thick channel through the group of diodes 116-120 or 126-130 and prevents further increasing of the voltage on the transistor. In this case transistors can be connected in series, which will allow to easily create high voltage system with operating voltage 10.sup.6 V and more with a control with light signals or by wireless.

Fig.13 comprises button "start" 134, button "break" 135, former 136, solenoid 178, transformer 137, the offered transistor-thyristors 140,145; Schottky diodes 138,1342,143,147, 148,160,162,174; diodes 150-159,164-173; resistors 139,141,144,147,149,161,163,175,176; switch 177, mobile contact 179, immobile contacts 180-183.

Resistors 139,141,144,147, 149,161,163,175 define boundaries of the latching.

Let the switch 177 be off. After the button "start" 134 is pushed, the former 136 switches on the solenoid 178 synchronously with alternative voltage. The mobile contact 179 is closed to contact 183 in several milliseconds and a small current flows to the contact 182 and the

transistor-thyristors 140,145 through resistor 176. In several milliseconds the mobile contact 179 is closed to the contact 182 and the transistor-thyristors 145,140. The former 136 sends the pulse on the transformer 137 in one cycle of voltage the moment the voltage zero crossing is detected. The transistor-thyristors 140,145 are switched on and the current begins to flow through the contacts 180,179,182. In several milliseconds the contacts 179,181 are closed and the current flows to the load by the shortest way. Thus, the switching on takes place without arcing.

Let the alternative current flow to the load through the contacts 180,179 and 181. After the button "break" 135 is pushed the solenoid 178 disconnects the contacts 179,181 without synchronizing with voltage. The current flows between the contacts 180,179,182 and the transistor-thyristors 145,140 for several milliseconds. After the current zero crossing takes place the transistor-thyristors 140,145 (the lifetime of the holes has to be not very long) are switched off and the current is switched off. Thus, the switching off takes place without arcing within one cycle of voltage.

AUTHOR:

*Edlin*  
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EDLIN S.D.